

Broad-bandwidth Metamaterial Antireflection Coatings for Sub-Millimeter Astronomy and CMB Foreground Removal

Completed Technology Project (2015 - 2017)



Project Introduction

Sub-millimeter observations are crucial for answering questions about star and galaxy formation; understanding galactic dust foregrounds; and for removing these foregrounds to detect the faint signature of inflationary gravitational waves in the polarization of the Cosmic Microwave Background (CMB). Achieving these goals requires improved, broad-band antireflection coated lenses and half-wave plates (HWP). These optical elements will significantly boost the sensitivity and capability of future sub-millimeter and CMB missions. We propose to develop wide-bandwidth metamaterial antireflection coatings for silicon lenses and sapphire HWPs with 3:1 ratio bandwidth that are scalable across the sub-millimeter band from 300 GHz to 3 THz. This is an extension of our successful work on saw cut metamaterial AR coatings for silicon optics at millimeter wave lengths. These, and the proposed coatings consist of arrays of sub-wavelength scale features cut into optical surfaces that behave like simple dielectrics. We have demonstrated saw cut 3:1 bandwidth coatings on silicon lenses, but these coatings are limited to the millimeter wave band by the limitations of dicing saw machining. The crucial advance needed to extend these broad band coatings throughout the sub-millimeter band is the development of laser cut graded index metamaterial coatings. The proposed work includes developing the capability to fabricate these coatings, optimizing the design of these metamaterials, fabricating and testing prototype lenses and HWPs, and working with the PIPER collaboration to achieve a sub-orbital demonstration of this technology. The proposed work will develop potentially revolutionary new high performance coatings for the sub-millimeter bands, and carry this technology to TRL 7 paving the way for its use in space. We anticipate that there will be a wide range of applications for these coatings on future NASA balloons and satellites.



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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

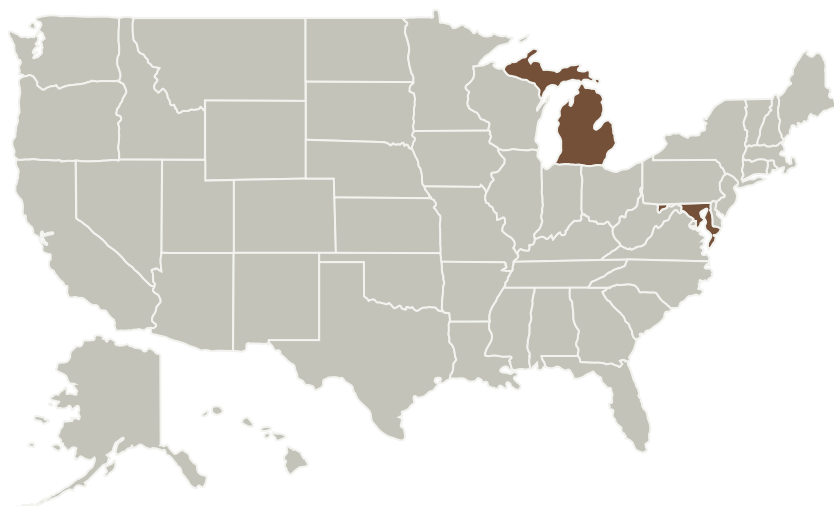
Astrophysics Research and Analysis

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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Michigan-Ann Arbor	Supporting Organization	Academia	Ann Arbor, Michigan

Primary U.S. Work Locations

Maryland	Michigan
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Project Management

Program Director:

Michael A Garcia

Program Manager:

Dominic J Benford

Principal Investigator:

Jeff McMahon

Co-Investigators:

Alan J Kogut

Edward J Wollack

Tracy M Mausolf

Technology Areas

Primary:

- TX08 Sensors and Instruments
 - └ TX08.1 Remote Sensing Instruments/Sensors
 - └ TX08.1.1 Detectors and Focal Planes

Target Destination

Outside the Solar System